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PRELIMINARY TESTS WITH DDVP VAPOR FOR THE
CONTROL OF *CULEX PIPIENS QUINQUEFAS-*
CIATUS IN CATCH BASINS¹

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Storm sewer catch basins are one of the problem sources of mosquitoes encountered in municipal mosquito control programs. Present methods requiring repeated treatments could be improved by a chemical measure effective for an entire breeding season regardless of the frequency or amount of rainfall. A measure of such potential is the residual fumigant technique (Mathis and Maddock, 1961; Mathis *et al.*, 1959, 1961; and Miles *et al.*, 1962) which has shown considerable promise against anopheline mosquitoes in homes. This technique involves the slow, continuous vaporization of DDVP from a dispenser over a period of 2 to 7 months, its effectiveness being dependent upon the amount of air movement and exchange. During 1961, tests were conducted in catch basins at Savannah, Georgia, to determine whether such a measure would kill *Culex pipiens quinquefasciatus* Say for a sufficiently long period of time to be of practical value.

METHODS. The thirty-two catch basins used were constructed of concrete or brick, were cylindrical in shape, approximately 3 feet in diameter, and had openings to the streets about 7 x 33 inches (Fig. 1). Half of the basins had an open (above the level of the residual water in the basin) 8- to 10-inch diameter drain, the remainder a submerged (beneath the surface of the water with an air lock be-

yond) drain. The water levels in the basins were 19 to 35 inches below the street level.

The formulation used consisted of 25-percent DDVP in a base of 25 percent dibutyl phthalate and 75 percent wax. This formulation was molded as a cylinder 1½ inches in diameter and 3 or 6 inches in length.⁴ Each dispenser was enclosed in a ¼-inch mesh hardware cloth container and suspended 12 inches below street level at the back of the basin. Eight basins were treated with 3-inch dispensers, eight with a single large dispenser, and eight with two large dispensers. Eight basins served as untreated checks. Four open and four submerged drains were included in each of the three treatments which were made on May 31-June 1.

The basins were surveyed for mosquito breeding immediately before treatment, 24 hours later, and subsequently on a weekly basis. Inspections were made with a pint enamelware dipper fitted with an extension handle. Three dips were taken in each basin and total counts made of any egg rafts and dead adults. Larvae were designated as small, medium, or large and counted separately according to size. When the number of any size larvae or pupae in a dip exceeded 25 or the number of living adults observed was above 10, the density was designated by a plus.

In adult evaluation, laboratory-reared specimens of *C. p. quinquefasciatus* strain originally derived from the catch basins were exposed once each week in seven

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⁴ The experimental formulation and different dispensers for this study were furnished by the Chemistry Section of the Technical Development Laboratories.

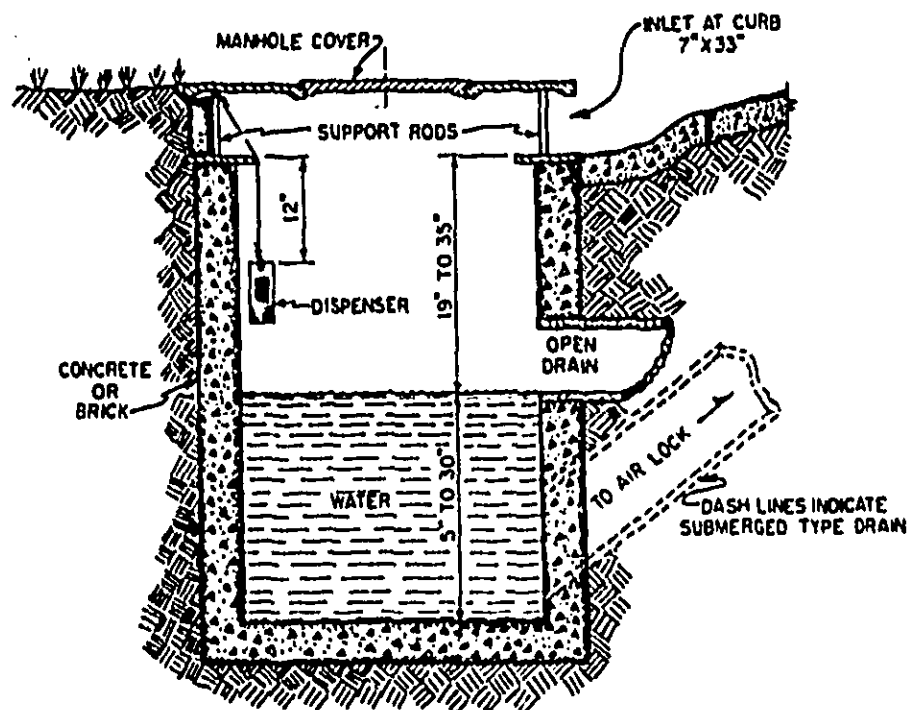


FIGURE 1.—Storm sewer catch basin showing the two types of drains.

treated basins and in one untreated basin. The 3-day-old adults of mixed sexes were anesthetized with CO_2 and transferred in lots of approximately 100 each to 4 x 3½-inch-diameter screen wire cages. The cages were closed with nylon netting and suspended near the water in the basins (Fig. 2). The adults were exposed for a maximum of 3 or 6 hours depending upon the speed of knockdown. Prior to exposure and until returned to the laboratory, the cages of mosquitoes were held in a screened box covered with wet cheesecloth. In the laboratory, the mosquitoes were anesthetized, transferred to clean cages, furnished 10 percent honey-water and held at 80° F. and 55 percent relative humidity for the determination of 24-hour mortalities.

Maximum-minimum air temperatures were determined weekly in eight catch basins selected on the basis of their rela-

tive exposure to sunlight. Thermometers were installed at dispenser height.

Observations on rainfall were based on information obtained from a rain gauge inside the study area.

RESULTS. Mosquito larvae were controlled for about 3 weeks in the basins treated with a 3-inch dispenser (Fig. 3). The basins treated with a 6-inch dispenser did not produce high larval populations until 16 weeks following application, but a small peak occurred after 7 to 8 weeks. The flushing action of rainfall (Fig. 4) was probably instrumental in preventing additional breeding between 8 and 16 weeks. There was no apparent difference between treatments with one or two large dispensers, nor in the results obtained in open and submerged drain basins.

Three-hour exposures of caged adults resulted in 100 percent mortality of females for 8 weeks with all treatments.



FIGURE 2.—Exposure of adult mosquitoes to DDVP vapor in catch basin; cage removed for photograph.

Two dispenser treatments killed all the females for 15 and 18 weeks in the open-drain and submerged drain basins, respectively (Table 1). Subsequent results were erratic. One large dispenser in the submerged-drain basins reflected an effective-

ness below 100 percent at 12 and 13 weeks, but then killed all exposed females to 21 weeks and more than 70 percent for 24 weeks. In the same basin, a 6-hour exposure produced more than 70 percent female mortalities up to 27 weeks. Evi-

TABLE 1.—Twenty-four hour percent mortalities of caged *Culex pipiens quinquefasciatus* exposed for 4 hours in catch basins treated with (a) one 3-inch dispenser, (b) one 6-inch dispenser, and (c) two 6-inch dispensers.

Week	Percent kill (Female)					
	(a)		(b)		(c)	
	O**	S**	O	S	O	S
10*	100	100	22	100	100	100
12	100	100	48	88	100	100
14	100	17	100	100	100***	100
16	0	0	0	100	100	100
18	2	0	0	100	10	100
20	..	..	..	100***	..	68
22	..	..	..	85	..	98
24	..	..	..	96	..	96
26	..	..	..	0	..	0

* Mortalities 100 percent through 8 weeks.

** O=open drain; S=submerged drain.

*** 100 percent kill at following week.

dence of decreased effectiveness with the small dispenser in the submerged drain basin was noted at 14 weeks. Adult mortalities tended to decline sooner in basins with open drains, except for one with a small dispenser. Presumably, the longer period of effectiveness in the submerged drain basins was related to the decreased ventilation therein.

Dead adult mosquitoes were not found in the eight untreated catch basins during the June-August period but were occasionally recovered from September to November (maximum number was four). Live specimens usually were detected in three to eight of the basins. In the basins treated with one or two large dispensers,

dead specimens were found frequently; in some cases as many as 12 to 14 adults were collected in three dips from a single basin. The recovery of the dead adults 27 weeks after the treatment suggests that exposures longer than 3 hours did occur under field conditions.

Air temperatures in the catch basins fluctuated much the same as ambient temperatures, but generally the weekly range was less. During the warmer months of July and August, temperatures in the basins with greater exposure to the sun increased beyond ambient level. This effect disappeared as the season progressed. Air temperatures of 100° F. did not kill caged adults exposed for 6 hours. Con-

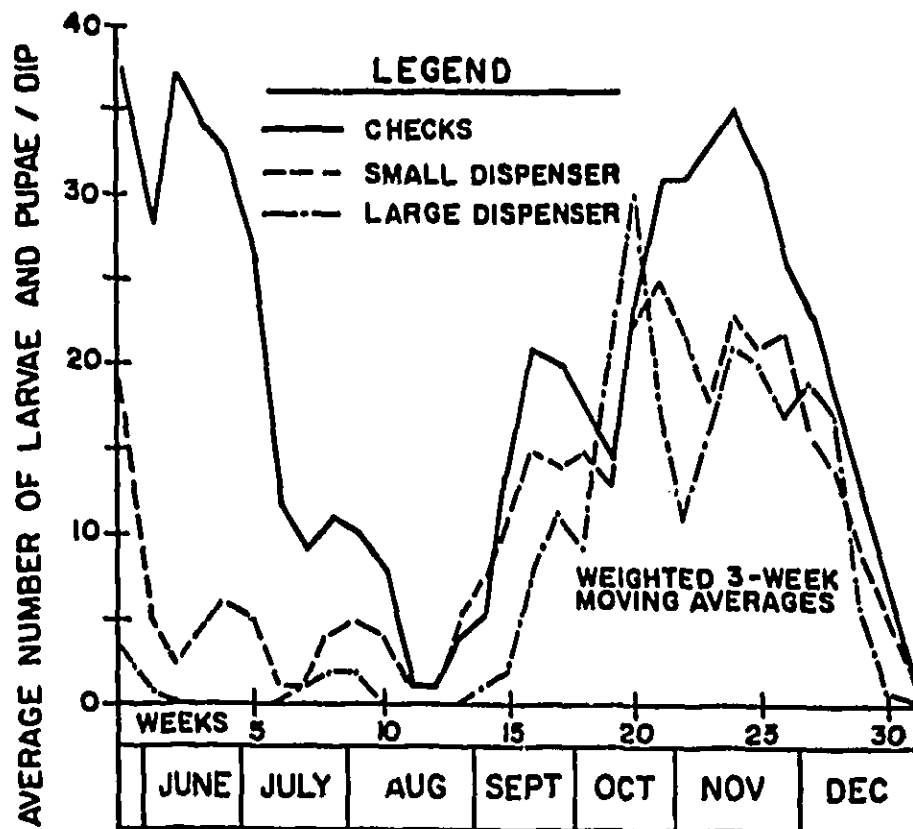


FIGURE 3.—Comparison of mosquito breeding in treated and untreated catch basins.

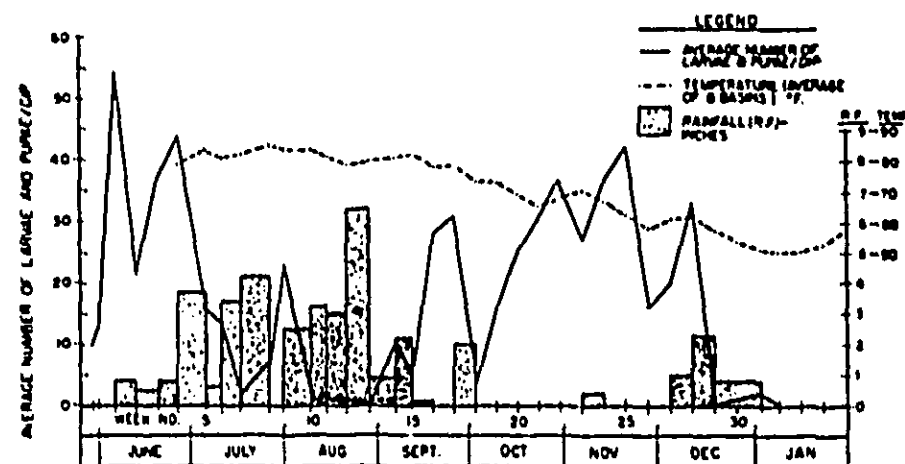


FIGURE 4.—Effect of rainfall and temperature on mosquito breeding in catch basins.

siderable breeding was observed when minimum temperatures inside the basins were below 50° F., even as low as 29° F. In the fall and winter periods, breeding was observed when maximum weekly temperatures were near 70° F. and average temperatures were near 60° F. (Fig. 4).

Observations were made on a limited number of atypical basins to determine the effect of differences in construction upon the control method. In deeper basins (48 to 52 inches between water and street level) treated with one or two 6-inch dispensers, larval development was prevented for 6 to 8 weeks. In three of the four deep basins, 3-hour exposures of caged adults did not result in complete kills on the initial inspection at 11 weeks. Similar results of adult exposure were obtained in four rectangular basins (42 x 44 inches; water level 22 to 44 inches below street) with 13-foot-long inlets, and in four rectangular basins (32 x 54 inches; water 48 to 56 inches below street) constructed with open outlets about 24 inches diameter and with two inlets—one in the curb and the second, measuring 20 x 20 inches located in the street. In comparison, typical basins gave similar larval kills but the adult mortalities remained at 100

percent for 17 to 20 weeks. The data for the atypical basins again indicate the negative effect of air circulation.

In two basins normally filled with water to street level, one or two 6-inch dispensers were installed beneath the water surface. Living adults and egg rafts were observed the week following treatment and at frequent intervals afterwards (as many as 33 rafts per 3 dips). Larvae were not present in either of the basins until the 17th week following treatment except during the third week when one basin contained numerous small larvae (average 19+/dip). Numerous light rains fell during the period and possibly prevented the accumulation of lethal amounts of DDVP in the water.

DISCUSSION. Although larvae were eliminated from the catch basins by DDVP vapor for only 6 to 8 weeks, high female mortalities were recorded for up to 24 weeks with 3-hour exposures. Based on the assumption that newly-emerged adults will remain inside the catch basins for at least 3 hours, DDVP dispensers show considerable promise in controlling *C. p. quinquefasciatus* in catch basins.

There was a difference in the susceptibility of the various immature stages to DDVP vapor. During any 24-hour post-

treatment survey, small larvae were seldom present, and always absent when the other stages had been eliminated. Medium and large larvae and pupae were progressively more difficult to kill.

Of the 226 exposures of caged adult mosquitoes to DDVP vapor that resulted in kills below 100 percent, male mortalities were equal to or higher than female mortalities in only 17 cases. When mortalities in the range of 10 to 60 percent are considered, male kill exceeded female kill in only two instances. Thus, the females of *C. p. quinquefasciatus* showed a greater susceptibility to DDVP than did the males.

Egg rafts were occasionally found in basins where caged adults succumbed to the DDVP vapor with less than 30 minutes exposure. Thus, it appears likely that *C. p. quinquefasciatus* females lay their eggs within a relatively short time after entering catch basins, particularly since the species is reported to oviposit at a rate of more than 15 eggs per minute by Horsfall (1955).

The amount of rainfall greatly influenced the number of immature mosquitoes found in catch basins (Fig. 4). During the relatively dry periods breeding

increased, but heavy rains flushed the immature forms out of the basins, particularly those with open drains.

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